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FEDERAL COMMUNICATIONS COMMISSION
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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish New Personal Communications Services	)	GEN. Docket No. 90-314 ET Docket No. 92-100
	)	
In the Request of	)	
	)	
Freeman Engineering Associates, Inc.	)	PP-79
	)	
For Award of a Pioneer's Preference in the 930-931 MHz Band to Provide Two-Way Data and Advanced Paging Services	)	

To: The Commission

Comments and Supplemental Information of
Freeman Engineering Associates, Inc.

Freeman Engineering Associates, Inc. ("Freeman"), pursuant to Section 1.415 of the Rules, hereby submits its comments and supplemental information in response to the Commission's Notice of Proposed Rule Making and Tentative Decision, FCC 92-333, released August 14, 1992 ("Tentative Decision") insofar as it tentatively concluded to deny Freeman's request for a pioneer's preference in ET Docket No. 92-100. In support hereof, the following is shown:

1. On June 1, 1992, Freeman timely-filed with the Commission its "Request for Pioneer's Preference" ("Request") in ET Docket No. 92-100 for the provision of two-way data and advanced paging services in the 930-931 MHz band.

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2. The Commission's discussion of Freeman's Request is set forth at Paragraph No. 154 of the <u>Tentative Decision</u>. There, the Commission incorrectly characterized Freeman's Request as setting forth "a general proposal to provide a number of paging-type services using 'advanced modulation techniques' and 'some current technology and some technology yet to be applied.' " The Commission set forth only one reason for its tentative decision to deny Freeman's Request, i.e., that Freeman did "not explain the technical basis for its proposal with greater specificity." This single finding constitutes the sole basis for the Commission's tentative conclusion that Freeman "failed to meet its burden of demonstrating that its proposal is new, innovative, and technically feasible and therefore that its request should be denied."

3. On October 5, 1992, Freeman filed with the Commission a "Petition for Reconsideration" ("Petition") of the Commission's <u>Tentative Decision</u>. As demonstrated in the Petition, the Request contained all of the showings required by Section 1.402 of the Rules and thus demonstrated that Freeman is entitled to a pioneer's preference as a matter of law. The Petition noted that Freeman would file the instant supplemental information to respond to the Commission's criticisms on the November 9, 1992 comment due date specified in the <u>Tentative Decision</u>.

4. As further demonstrated in the attached engineering statement of Arthur K. Peters (Attachment A hereto), Freeman's proposal is new, innovative and technically feasible. Mr. Peters' statement provides a more detailed description of the Freeman paging system, including its feasibility and the new and innovative features and concepts which distinguish it from existing, conventional systems. Thus, applying the criteria established by the

Commission to justify the award of a pioneer's preference, Freeman's proposal is at least as innovative and feasible as Mtel's request for a pioneer's preference, which the Commission tentatively granted at Paragraph Nos. 149-151 of the Tentative Decision.[1]

5. In addition, the attached TRANSCOMM studies (Attachment B hereto) demonstrate the existence of public demand for the services proposed in Freeman's Request. This demand is viewed from both the public's perspective and that of the operator of the system.

6. In response to the request for public comments set forth at Paragraph Nos. 50 and 51 of the Tentative Decision, Freeman submits that the Commission, as a result of its Pioneer's request, should provide for paired asymmetrical channels at 900 MHz with a bandwidth of at least a 150 kHz on the forward channel. A base to mobile 150 kHz channel bandwidth would allow for more efficient operations and lower costs to subscribers. (see Attachment A) Allocation of these wider bandwidths would allow greater flexibility in the development of new technology and services, as demonstrated, for example, by Freeman's Request. Advanced modulation techniques of the type proposed by Freeman require these wider bandwidths for proper and efficient operation[2] and should lead the Commission to allocate channels wider than 50 kHz.

7. Freeman believes that its Pioneer's Preference Request should lead to the Commission's adoption of rules which allow greater than 50 kHz

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[1]While Freeman does not challenge the Commission's award of a pioneer's preference to Mtel, the point is that if Mtel has satisfied the established criteria to justify a preference, so has Freeman. Or, stated differently, the Commission has failed to clearly enunciate why Mtel's request justified the award of a preference but Freeman's did not.

[2] See Freeman's comments on Proposed Rulemaking Nov. 9, 1992.

channels. Freeman's demonstration of innovation and technical feasibility should be convincing to the Commission that new and 'forward looking techniques will come along which should be accommodated by the new AMS allocation.

8. Freeman also believes that its Pioneer's request should lead the Commission to allocate the reverse channel for use by both traditional subscribers and hearing and speech impaired persons. The reverse channel solves a significant problem to this class of individuals.[3]

9. With the grant of Freeman's Pioneer's Preference, the Commission will be giving the public, among other things, voice paging service in sufficient quantity and quality to allow this needed[4] service to grow in a situation that is analogous to what the cellular frequency allocation did to IMTS.[5]

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[3] Comments of Dr. Charles I. Berlin, Gen. Docket No. ET-90-314, ET Docket 92-100, PP79, Par. 4-6.
[4] See TRANSCOMM Exhibit B.
[5] Reply comments of Minilec Service at Page 5.

WHEREFORE, Freeman requests that Paragraph No. 154 of the Tentative Decision be set aside, and that Freeman's Request for Pioneer's Preference be granted.

Respectfully submitted,

Freeman Engineering
Associates, Inc.

By: W. Harrell Freeman

W. Harrell Freeman
President

Of Counsel
Blooston, Mordkofsky,
Jackson & Dickens
2120 L Street, NW
Suite 300
Washington, DC 20037

Dated: November 9, 1992

ATTACHMENT A

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ENGINEERING STATEMENT OF ARTHUR K. PETERS, P.E.

The firm of Arthur K. Peters, Consulting Engineers, has been retained by Freeman Engineering Associates, Inc. (Freeman), to provide a more detailed explanation of the paging system set forth in Freeman's Request for a Pioneer's Preference previously filed with the FCC. The FCC rejected Freeman's application on the basis of insufficient technical information. This report provides in detail all of the features and services summarized in Freeman's original request and describes how Freeman's system meets or exceeds the Commission criteria for awarding such a preference.

INTRODUCTION

In its application, Freeman proposed advanced paging services utilizing base to pager channels of 150 KHz and response (pager to base) channels of 56 KHz. On these channels, Freeman referred to services which included voice transmissions, data transmissions, voice mail messaging, special services for the deaf, message delivery information, systems distributed over large geographical areas, retransmission of messages that were incorrectly received and efficient use of the spectrum for paging and text messaging. The details presented here show that Freeman's system meets or exceeds all expectations listed in Freeman's Request.

It will be shown that Freeman's system is extremely efficient compared with current paging practices for all types of paging including voice, tone only, numeric and alpha numeric. Because of the relatively low speed of voice transmissions resulting from individual message time lengths, paging system operators have all but abandoned voice messaging in spite of the fact that voice messaging is still the most efficient way to convey large amounts of data to a pager from any telephone with no special devices required.

Freeman's system will utilize existing technology in a new and innovative application. Pagers for this service will cost about the same as current pagers but utilize very different, already existing, more modern technology to realize the enormous efficiencies described. Transmitters and equalizing techniques required for this system are derived from present equipment with few or no required modifications. Manufacturers and suppliers have been contacted and it has been determined that all of the equipment required for this enterprise could be in service within a year's time at costs comparable to current existing paging system components.

When discussing the word "pagers" in this document, a pager can be defined to be any digital device which receives data over the system. This can be in the form of a printer, a telecommunications device for the deaf (TDD), facsimile device or any other digital device which generally employs a predominately unidirectional data path. We have termed the main 150 KHz channel the forward direction and the 56 KHz response channel the reverse direction. The reverse channel will be typically used for message control, short responses and automatic verification of delivery of a paging message.

OVERALL SYSTEM DESCRIPTION

FCC Rules Changes Required to Implement the Proposed System

The system proposed here is not licensable under current FCC Rules. The Commission is currently looking toward allocation of advanced paging channels in GEN Docket 90-314, ET Docket No. 92-100 as described in the NPRM released August 14, 1992. In that document, the Commission requests comments concerning advanced paging services in the 901-902, 930-931 and 940-941 MHz services. At Paragraphs 48-52 the Commission has listed several alternative allocation structures for these frequencies. Freeman proposes that provision be made for highly spectrum efficient systems such as described here. Additionally, it should be recognized that multi-transmitter simultaneous transmission systems require special and very precise distribution of signals over wide areas. In conventional paging systems, simple radio links are used for distribution of signals over large geographic areas. Similar arrangements would be required for simultaneous, wide-area wideband systems, such as the one proposed here. Therefore, some means for radio distribution would be beneficial. However, interstation distribution can be accomplished using conventional microwave techniques in other frequency bands.

Frequencies and Bandwidths

Freeman seeks allocation of 150 KHz bandwidth for forward channels and 56 KHz bandwidth for reverse channels. It should be noted that if it is more convenient, the 56 KHz value could be changed to 50 KHz to permit more uniform allocations. In this case, a single channel allocation would consist of a 150 KHz wide forward channel and a 50 KHz wide reverse channel.

Of the three 1 MHz bands under FCC consideration, it would be most desirable to place the 150 KHz transmission channel or channels adjacent to other high power paging transmission bands. The Freeman system utilizes effective radiated power outputs similar to those currently authorized in the 931 MHz band. Thus, it would be reasonable to assign these wideband channels in the 930-931 MHz band.

The reverse response channels should be allocated in a band which is not immediately adjacent to high power transmission bands. This requirement exists because the response channels will typically have very low power transmissions of very short duration.

The system proposed here will function properly with any channel allocation adopted by the FCC having similar bandwidths.

Since the proposed system costs are not much different from existing systems, it is not difficult to justify utilizing this system for smaller areas which will permit access to other compatible systems. Because of the enormous capacity achieved in this system, larger population centers will likely use this system first while rural areas will institute the service as needs arise. There are no technological or cost factors involved in this proposed system which would restrict the system's use in rural areas.

System Description and Operation

The Freeman system consists of a forward and reverse channel. The forward channel is comprised of a system of 32 subchannels which are modulated on a standard FM transmitter in a wideband mode. Each of these subchannels carries data at a rate of 9600 bits per second (bps). The first subchannel (Channel 1) is a synchronous channel to which all pagers will be tuned when idle. Pagers will synchronize themselves to the data on Channel 1 using techniques that are well established in the paging industry, namely those employed in POCSAG synchronization.[1] The normal POCSAG battery saving techniques are employed in this proposed system and provisions are available for different battery saving techniques due to slight format changes in the coding structure. The code formats and protocols are addressed later in this presentation.

It is anticipated that pagers will utilize digital signal processing technology (DSP) which are specialized computer hardware devices which enable large volumes of computations. Using DSPs, the pager technology will be highly simplified and made more versatile and much "smarter" than ever before.

In an idle condition pagers will be tuned to Channel 1 decoding the synchronous bit stream which consists of paging addresses. When a pager

[1] Unlike POCSAG, since the system utilizes only one signalling protocol, the preamble signal will rarely be used except immediately after system interruptions.

detects its address it decodes the channel number contained in the address codeword. Codes and bit allocations within the protocol are described in the Code Format and Protocol section. There are several currently assigned actions a pager may take based upon information contained in its address codeword. There is also spare capacity in the protocol to make future assignments as the system evolves. Currently, the system can address over two million pagers with expansion potential to over eight million on this single 150 KHz channel.

The system operates as a calling channel/working channel conventional radio system. When the pager detects its address in the synchronous bit stream, a message channel number of zero indicates that there is no pending message at which time the pager simply alerts the user and resumes its decoding of Channel 1. If the message channel number equals one, then the system is requesting that the pager transpond its identification on the response channel. This message may be sent by the system for any number of reasons but generally it will be to locate the pager and/or determine if the pager is within the system area and receiving decodable signals. If the message channel number is greater than one, the pager will then move to one of the other 31 subchannels and acquire bit and word sync on the new channel. Once the message is received, if there are no errors, the pager responds on the reverse channel with its address and the message channel number.

Pager responses will generally be automatic and issued upon receipt of a message with no errors. If the message is not received or if the pager has received an error, the pager may send an indication back to the system to resubmit or retransmit the message. In a preponderance of paging cases, a calling party will receive an immediate response. In fact, Freeman anticipates converting the pager responses, in many cases, to synthesized voice responses such as "Message received". In some cases, a selection of responses is possible, depending upon the message sent to the pager. In these cases, the user will select a response from two or more buttons placed on the pager. Responses such as yes, no, defer, delay are all possible and interpretable at the user's discretion without specific system involvement. More complex responses and responses requiring multiple words can also be relayed back to the system over the reverse channel.

Pagers equipped for voice transmissions will be able to store five 15-second voice messages to be recalled at will. Voice messages are digitally encoded by the system and sent at greater than a real time rate. This compressed format will provide a high-quality voice message with a small amount of compression. It will permit a 15-second message to be transmitted to a pager in 10.95 seconds including subchannel acquisition time.

Persons with hearing disabilities will receive unique benefit from the Freeman system. When deaf persons are paged on conventional paging systems, they may have significant problems responding. The proposed system allows the person to respond by pressing a button which will immediately be communicated back to the calling party. The response can be converted to a voice response, returned via E-mail or sent as a character string if the calling party placed the call via a TDD.

Benefits can also accrue to persons with other types of disabilities. There are no system technical limitations to receiving emergency origination messages from pagers on the response channel. For example, as is currently provided in other services, medical emergencies can be annunciated by originating a special message from a small pager. The chief advantage to using the Freeman system is that a large infrastructure will be in place and underwritten by large numbers of diverse users.

System expansions such as using messages with alternative code formats are potentially available by defining one of the reserved message type words. In the future, even combinations of message formats including higher speed data simultaneously utilizing two or more subchannels are possible with software changes in the system. For example, a message type (either Type 3 or Type 4) can be defined to permit commands and instructions to occur in the messages themselves. Once the pager intercepts its address and transfers to a subchannel for message processing, the message word can contain further instructions for the pager to also acquire one or more additional subchannels for simultaneous transmission or to completely change its codeword structure. Procedures like this will be possible for future equipment without affecting the compatibility or usability of existing equipment. Thus, the proposed system is fully expandable without obsolesence.

While discussing the features one has a tendency to remain with familiar objects used in paging systems. However, in this case the pager should acquire no fixed definition and can literally be a computer terminal, voice messaging system, facsimile terminal and a host of other types of devices. The system will automatically send appropriate messages to the appropriate devices in the expected formats. Should a format change be required, one of the codewords would define an extended messaging service in which formatting is performed on a negotiated basis with the specific device. This requires some form of response system.

The system can manage and keep track of r-f transmissions on the forward channels. However, users can respond to messages either digitally or with push button responses. Consequently, the reverse channel will see random r-f responses which, on a conventional channel, would be mutally destructive. The Freeman paging system anticipates utilizing code division multiple access (CDMA) techniques on the reverse channel which allow simultaneous access by large numbers of pagers without interference on the reverse channel. This complex technique is easily handled by DSPs. Since the pagers are already intended to utilize DSPs, no penalty is extracted by using CDMA techniques on the reverse channel because the pager DSP has enough spare capacity to process CDMA responses along with its normal decoding of the subchannels and the processing of Vocoder or digitized voice messages.

Reverse channel receivers will be located throughout the system service area so that the low energy (approximately 1 joule) transmissions from the pager may be sent back to the system. It is anticipated that these receivers will be located every two to three miles depending upon topography, building characteristics and attainable receiver antenna heights.

Unassociated with the technical facets of the transmission system are certain operational features which may be readily employed without affecting transmissions. For example, while voice responses are not anticipated in the system, a code sent from the pager to the terminal may be converted into a synthesized voice message with any number of meanings. This could be accomplished on a per user basis with voice and pager response definitions customized by the user. Button number one, for instance, could consist of the message "Don't do anything about this now. Wait until I return to the office". When the user presses button number one, that voice message can be played back to the calling party or, upon previous arrangement, can be forwarded to a voice mail box with or without the original message accompanying the response. Encoded responses are virtually unlimited; however, in most instances, Freeman anticipates that the responses will be simple and fast and be returned directly to the calling party without delay. In the event that the system gets backed up or delayed, which is highly unlikely, responses may be either printed or sent to an operator's console or any number of different locations. A user responsive paging system opens a whole new world of communications strategies.

SYSTEM CAPACITY

A natural question to be asked by spectrum administrators is "Why should wideband channels be allocated under any circumstances?" There is some opposition to allocating wideband channels which include such issues as the restriction of competition. Freeman anticipates that more than one wideband channel will ultimately be allocated by the FCC for competitive purposes. Furthermore, current paging device limitations are mentioned in most discussions about wideband spectrum allocation. With a wideband channel, new innovative services could provide new forms of communications which are currently not available and not attainable using conventional 25 KHz wide channels. The concept of sending large amounts of data to a terminal or even to a group of terminals cannot be done efficiently in the 25 KHz structure. The Freeman system has the capability of sending a great deal of data very quickly and will permit new uses of the one-way technology. This, along with the response mechanism to invoke retransmissions, will make the system fast and highly accurate.

Freeman is requesting allocation of the equivalent of eight conventional 25 KHz paging channels. In those channels, if we assume that two would be used for response channels, then it is more likely that six forward channels and two reverse channels must be compared against the one 150 KHz forward channel and one 56 KHz reverse channel of the Freeman proposal. Since for the Freeman system the ultimate capacity relies on the capacity of the forward channel we will not consider the reverse channels in our comparisons. Freeman is proposing to use 30 of its 32 subchannels for data at 9600 bps. This raw data capacity is five times the information rate of six conventional channels operating at the same speed. Currently, most paging channels do not operate at this speed. However, any new 25 KHz allocations could probably use 9600 bps. Freeman's system has the capability of utilizing two or more data channels simultaneously. This could not be simply done with conventional channels. The efficiency obtained by utilizing a calling/working channel configuration also cannot be reached using 25 KHz channels in the conventional sense. Even if some sophisticated scheme were adopted to expand the number of subchannels used on a conventional channel, with resulting greater capacity for tone-only, alpha-numeric and numeric paging, there would still be very little capacity for conventional voice messaging. The

Freeman system is considerably more versatile than would be the reconfiguring of conventional channels. In short, the use of wideband channels should not be ignored in allocations for advanced paging systems.

Capacity of any paging system is very difficult to quantify because one must make assumptions concerning the mix of various paging services. These assumptions would also necessarily include devices and processes which are not yet available. Rather than attempt any form of mixture, each of the various conventional paging types will be analyzed and compared against conventional channels to illustrate the enormous capacity and innovation of the proposed Freeman paging system.

Subchannel 1 encodes the pager addresses and designates a data channel for message delivery. This information is contained within a single 32-bit word for which 18 bits are used as a pager address with 3 address bits assumed, based on the group to which the pager is associated. Thus, an effective 21 bit address is obtained which has the capability of uniquely addressing approximately two million pagers. Two bits in the codeword are reserved for future expansion and could be used to expand the address field which would bring the unique addressing capability to something over 8.3 million subscribers. Since it is unlikely that the system will ever reach its full addressing capacity, only 2 million unique addresses have been specifically designated. The reason 8 million subscribers are unanticipated is that the mix of pagers will likely limit the capacity of the system to something less than 8 million users. As will be shown, if most of the users are voice subscribers, the system will achieve a considerably lower capacity than if the system were to be composed of mainly tone-only or numeric customers. In the latter case, the system would be limited by Channel 1's ability to process pager addresses. In the former case, the system would be limited by the capacity of the data channels. None of these should be viewed as limitations since the system capacity is enormous.

By far and away the most versatile form of paging is, and always has been, the voice message. Words convey meaning, but the voice also conveys emphasis by its intonation. The simple words "call me now" can have various meanings depending on the inflections given each of the words. Moreover, for complex messaging, the voice message, particularly with pager recording capability (which can be instituted from any telephone) can be much more versatile and user friendly than any digital form of messaging. For many current users of paging systems, voice messaging could be a very satisfactory paging method. System operators have discouraged the use of voice paging because, in the past, voice paging has not been efficient and did not permit service to as many customers on a channel as do other paging methods. Paging systems did not drift away from the voice format simply because of customer desires. It was purely an economic consideration.

Freeman anticipates allowing average length voice messages of approximately 15 seconds. If one visualizes a typical one minute commercial, there is a great amount of information that can be conveyed in a 15-second message. Compression techniques are to be used in the system which will permit a 15-second message to be transmitted in about 11 seconds.

The conventional way to determine system capacity is to compute the number of calls that may be processed during a busy hour. This is an old telephone convention which is used by the paging industry. The industry average for paging rates is approximately 0.1 calls per busy hour per paging subscriber. This means that the system can usually obtain a subscriber capacity of ten times the number of calls it can process in the busiest hour of a day. With 15-second voice messages, the proposed Freeman system can process 9,863 calls per hour. This corresponds to a system capacity of 98,630 voice subscribers. In a conventional voice system it is common that a voice paging channel have a maximum capacity of approximately 1500 subscribers. If we assume six channels available for voice messaging (reserving two for responses), the equivalent conventional system capacity would be 9000 subscribers. The Freeman system represents an expansion of more than ten times over the conventional voice paging channels.

Equally impressive and innovative is the capacity of the Freeman paging system to process alpha-numeric messages. These are digital messages which utilize letters and numerals and which are displayed on a screen or readout. Assuming an average message length of 60 characters encoded as ASCII characters with eight bits per character, the Freeman system can process, including subchannel acquisition times, 952,066 calls in a busy hour. If the number of bits representing a character were reduced to seven, the processing rate would be proportionately higher. This calling rate would support over nine million subscribers which exceeds the system addressing capacity of about eight million. (This is the limitation imposed by the bit-length of the available address.) If some pagers received two or more calls during the busy hour, the system will be capable of processing the full 952,066 calls in the busy hour. On a typical conventional alpha-numeric channel, it is unlikely that a channel would sustain 40,000 alpha-numeric subscribers assuming a 60-character message. That would yield a six channel capacity of 240,000 subscribers compared to Freeman's 9.5 million, an improvement factor of about 40 times. Even if the conventional channels were operated with a bit rate similar to the Freeman proposal, there would still be a four times benefit with the Freeman system based simply on the number of channels achieved.

The Freeman system has such a large capacity that the number of numeric pages (each comprising a 10-digit, BCD encoded, numeric message with a tone alert) that can be carried by the system, far exceeds the number of possible address codes. That is, the Freeman system has the ability to process calls to support over ten million tone-only/numeric paging subscribers, but its available address space is only capable of addressing some eight million.

Because the numeric and tone-only messages are so short, the number of messages which can be processed will be limited by the rate at which addresses can be sent over Channel 1. This rate is 282 calls per second which equates to slightly more than one million calls per hour. The system is thus able to support up to ten million subscribers on its calling channel of which eight million are uniquely addressable. Thus, if all users on the system were tone-only or numeric subscribers, the system could process and support the maximum number of callers which it can uniquely address.

A typical paging channel, of which there are few purely numeric/tone-only in existence, could probably attain a subscriber capacity of 75,000. Even if the number were 100,000 (with a six-channel capacity of 600,000 subscribers) the Freeman system would represent greater than ten-times expansion over conventional systems.

If we study the issues of mixing the different paging types and introducing hypothetical large volume processing, we can hypothesize virtually any position desired. The important issue is that the Freeman proposal represents an order of magnitude increase over present systems and a substantial increase over the capacity of the equivalent number of narrowband paging channels.

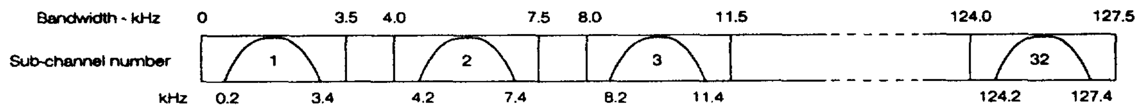
There is evidence that when pager volumes reach the million range, pager prices will likely be less costly than pagers currently available in conventional services. This includes the cost of some perceptually higher priced digital chips such as the DSP.

Other issues involve infrastructure. Eight conventional 25 KHz channels require eight times as many transmitters, transmission lines, antennas, etc. to achieve an equivalent system. Moreover, the institution of 25 KHz response channels makes random access transmissions nearly impossible without having a discrete response channel available for each conventional 25 KHz forward channel. Thus, the assumptions made in the capacity comparisons above show a further advantage of the Freeman system. A conventional system requires a discrete response channel for each forward channel. Therefore, the two Freeman channels would be equivalent to four forward and four response conventional channels. Even with very high data rates, the narrowband 25 KHz channels could not match the capacity of the proposed Freeman system.

The Freeman system, which proposes a 9600 bps data rate, has selected that data rate because it is easily achievable, can be provided quickly and has already been accomplished using DSP technology. It is anticipated that 19,200 bps could be accomplished without much additional effort. This would virtually double the capacity of the Freeman system but would also require the use of Channel 2 as an additional, simultaneous calling channel along with Channel 1. This would complicate the simultaneous transmission equalization techniques to be used with the Freeman system. That same data rate, on a conventional 25 KHz channel, would be virtually impossible to equalize except in a few rare locations where topographic and geographic conditions are ideal. In the caverns of New York City and the Grand Canyon, simultaneous transmitters would be virtually impossible to employ at the higher data rates. Freeman's method of equalization will be explained in a subsequent section.

R-F CHANNEL STRUCTURE

Forward Channel



The Forward channel will have 32 sub-channels, each capable of 9600 bps data. Sub-channel 1 is the baseband and carries unaltered signals from 200-3400 Hz. Sub-channels 2-32 are similar to sub-channel 1 except they have been shifted in frequency to be centered in their respective sub-bands.

Figure 1 - Forward Channel Modulation

The forward channel has an effective r-f bandwidth of 150 KHz in the 930 MHz frequency band. The channel will employ narrow-band FM transmission modulated by a system of subcarriers which has an upper frequency of 127.5 KHz. Each subcarrier will have a voice-grade bandwidth which is approximately C-Message weighted with modulation frequencies from 200 Hz to 3400 Hz. The address or calling channel will occupy the base band on subchannel number 1. Subchannels 2 through 32 will each be derived utilizing widely available modern technology. The 32 channels will then be pre-emphasized and used to modulate an FM carrier to approximately ±75 KHz deviation. Each subcarrier will be given an insertion level to achieve the same modulation index. Similar techniques have been utilized for many years in other radio services and represent relatively common equipment and processes.